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AgTech Centre research targets practical nozzle information

With the ever-expanding line-up of nozzles and sprayer technology, producers are left wondering what nozzle to use. Here's help.

The simplified way to understand the pace of change in crop spraying developments is to think of what farmers on the front lines of technology have had to learn.

By 2001, farmers were faced with nearly a dozen new nozzle manufacturers and even more nozzle choices within a span of three years. Farmers' questions showed there were lingering concerns about several sprayer types such as low volume, air assist and electrostatic sprayers, questions regarding herbicide efficacy at reduced water and chemical rates that were never resolved.

On top of that, by then high clearance spraying speeds were up to 30 km/h from 8 km/h with pull type sprayers. With this increase in speed, the yellow 02 nozzles used to apply 10 gpa the past 25 years gave way to large sized 04 and 05 tips. Air induced and pre-orifice nozzle types further increased spray droplet size.

Crop protection companies and other researchers did not have the mandate, experience or resources to test sprayers in typical field conditions and operating speeds, says Brian Storozynsky, sprayer technology specialist at the AgTech Centre. Concerned with the large spray droplets some nozzles produced, farmers looked to the AgTech Centre for answers regarding spraying technologies, reduced rates and spraying speeds.

Comparison data lacking

Competition in the spraying industry is tremendous. New technologies are introduced into the market quickly without much research data on effectiveness. Experience shows nozzle information is limited to nozzle types and spray classification, but not much beyond that considering the vast spraying conditions applicators face. With the lack of practical nozzle information, the most common question is, "Which nozzle is doing a better job?"

In this Issue

"Producers really want to know the most effective nozzle that provides the best balance between coverage and reduced drift," says Storozynsky. "After many years of testing, some key findings will aid applicators. Producers should not sweat the small differences in spray droplet size and deposition when selecting nozzles."

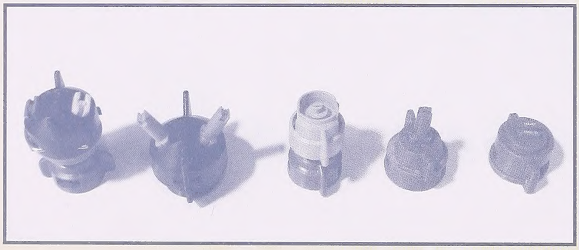
Sprayer and nozzle technologies are evaluated at the AgTech Centre based on the following three tests: spray drift, spray deposition and chemical efficacy. The Centre has built research sprayers equipped with several new spraying technologies. They are designed for scientific studies following standards for full size spraying equipment operating at field speeds and nozzle sizes.

Testing sprayers in typical field conditions and operating speeds is key in AgTech research. Detailed testing is performed on nozzles using specialized facilities such as a wind tunnel, spray table patternator and spray deposition track.

Nozzle types

Several new broadcast spraying technologies are on the market and they all have a common denominator: use of air. Air can be used for atomization, as a carrier, or induced into spray droplets. Many nozzle technologies are used together; currently, twin nozzles and spraying angles are the topic of many questions.

Manufacturers of new spraying technologies claim to improve spray droplet quality, penetration and deposition on its intended target. AgTech Centre's chemical efficacy studies include six spraying technologies that fit the six spray classifications set out by the American Society of Agricultural and Biological Engineers (ASABE) standard S-572.



Air induction (venturi) nozzles. Air induction or venturi-type nozzles have been used to apply herbicides in cereal crops in Western Canada since 1996. A venturi nozzle has an internal orifice that regulates flow and an exit flat fan nozzle that shapes the spray. Inside the nozzle body, spray solution passes through a tapered passage called a venturi. As the passage diameter decreases, spray is accelerated through the nozzle.

At the tapered passage a vacuum is created, causing air to be sucked from outside the nozzle body through air passages. Spray solution and air are mixed in the nozzle body chamber before exiting the external nozzle tip. Compression in the mixing chamber results in air bubbles forming inside the liquid spray droplets. This produces larger spray droplets that, according to some nozzle manufacturers and distributors, have a positive effect.

The AgTech Centre tested several manufacturers' venturi nozzles and classified them into two groups: low and high pressure. This made nozzle selection easier for spraying applications in windy conditions. Venturi nozzles with an operating range from 150 to 475 kPa (20 to 70 psi) were grouped as low pressure venturis and usually produce smaller spray droplet diameters than high pressure venturi nozzles. Venturi nozzles having an operating range from 275 to 830 kPa (40 to 120 psi) were grouped as high pressure and produced coarser spray droplet diameters than any flat fan nozzle types. Some nozzle manufacturers claim coarse high velocity spray droplets penetrate some crop canopies better than fine spray droplets.

Twin venturi nozzles. These nozzles are used in pairs via a special nozzle cap, nozzle body or nozzle tip design to deliver two sprays. One spray is orientated forward at 15, 30 or 45 degrees and the second is orientated backward, typically at the same angle as the front nozzle. The design advantage is to treat both sides of the targeted plant, tests have shown this to be effective on vertical stems and leaves. Although twin nozzles are not a new concept, twinning venturi nozzles may be better than its predecessor due to less nozzle plugging and less spray drift.

Air assist systems. Air assisted spraying technologies have been used to apply herbicides and foliar fungicides for several years. The centre's tests have shown the combination of nozzle spacing at 255 mm (10 in), small spray droplets and extra plant coverage benefit foliar fungicides. The air assist system meters the liquid mixture through an orifice into a delivery tube. An air stream passes around the delivery tube that atomizes the liquid solution as it exits the delivery tube. According to the manufacturer, the main air stream physically moves the plant, forcing spray into it, and helping increase spray penetration and coverage to both sides of the plant leaf.

A dual system using conventional flat fan nozzles and an air blast is another type of air assist system. The conventional nozzle meters and atomizes the spray solution that is directed at a forward angle where it meets a blast of air from the air system. The air blast provides a curtain of air that opens up the plant canopy and aids the spray to the target. According to the manufacturer, the dual system reduces spray drift and increases deposition in heavy crop canopies and adverse wind conditions.

Vari-Target nozzle. Another nozzle type the Centre is testing is Vari-Target nozzles. This nozzle controls flow rate and maintains similar spray patterns and droplet quality over a large range of application rates and speeds. At a spraying speed of 12 km/h, application rates from 36 and 450 L/ha (3 and 40 gpa) can be easily obtained with one nozzle size. Currently, three nozzle caps are available to spray Medium, Coarse and Very Coarse spray droplets. Finally, the automatic rate controller, developed in the early 1980s, can be used to its full potential when using these types of nozzles. Growers can now do most of their spraying with one nozzle size.

Air assist, venturi and twin nozzles

Over the past seven years, the Centre has tested sprayers and nozzles in several cereal, oilseed and special crops that included field peas, beans and potatoes. For example, in the summer of 2005 seven different types of nozzles were used to apply a single application of

a foliar fungicide on a bean crop. Two types of venturi nozzles, two types of twin nozzles, two air assist systems and an extended range nozzle were tested.

With just one application of the foliar fungicide, nozzles with better coverage and spray droplet size should have done better if, in fact, more coverage and appropriate droplet size always translate to better control. Although there was no significant difference in disease incidence among nozzle types, disease incidences tended to be lower in plots sprayed with air assisted flat fan nozzles, twin venturi nozzles and the high-pressure venturi nozzles. This may suggest the air blast used to open the crop canopy and draw the spray in may be beneficial in applying foliar fungicides.

Other field tests have shown similar results regarding spraying technology. Although some differences in weed control occurred among nozzle technologies, these differences were statistically insignificant.

Chemical rates were reduced to try and highlight differences among nozzle types. However, this is not a suggestion for growers to reduce chemical rates. Even though wild oat control was reduced, weed control among nozzle technologies was not significantly different with one exception: high pressure venturis that produce Very Coarse droplets and fewest number of droplets per cm^2 had less wild oat control than the other nozzles tested.

This result indicates a limit exists on the size of spray droplets that can be used when applying herbicides and that an adequate coverage is required when using venturi nozzles.

Effect of Water Rates

Growers have questioned water rates for many years considering some sprayers and aerial applications have been using less than 56 L/ha (5 gpa). Industry believes high water rates provide the proper coverage and penetration needed for most applications. Current water rates used by growers in Southern Alberta to apply foliar fungicide, for example, range from 112 to 224 L/ha (10 to 20 gpa) and to apply herbicides, rates range from 56 to 112 L/ha (5 to 10 gpa). In some desiccation applications rates up to 448 L/ha (40 gpa) are recommended. High water rates certainly reduce spray drift and provide extra coverage.

Overall, water application rates of 112, 224 and 336 L/ha (10, 20 and 30 gpa) in the 2005 fungicide study in dry beans did not significantly affect disease incidence. This trend was similar to studies done between 1999 and 2001, with other foliar fungicides on dry beans using water rates of 56 and 170 L/ha (5 and 15 gpa).

Over four years, water rates of 56 and 224 L/ha (5 and 20 gpa) used to desiccate potato crops prior to harvesting were studied. Again, no significant difference resulted from using less water as both treatments still resulted in requiring a second application to completely desiccate the potato vines.

Five years of testing using herbicides in field peas showed similar results in water rates. At recommended chemical rates, results were similar for 112 L/ha (10 gpa) and 56 L/ha (5 gpa) with all nozzle types. Only one year of a five-year study using a contact herbicide in a canola crop showed applying 56 L/ha (5 gpa) had less weed control than at 112 L/ha (10 gpa). This may be attributed to moisture conditions and weed populations being abnormally high that spring. All nozzles used in these studies were operated at manufacturers recommendations. In extreme growing conditions like advanced weed stage and high weed populations, plots sprayed at 112 L/ha (10 gpa) showed weed control was usually more consistent than at 56 L/ha (5 gpa). This is an indication that things can go wrong if recommended water and chemical rates are not adhered to with some chemical types.

Producers can check with the AgTech Centre for the latest information on this and other research. ✦

Nozzle studies' key findings

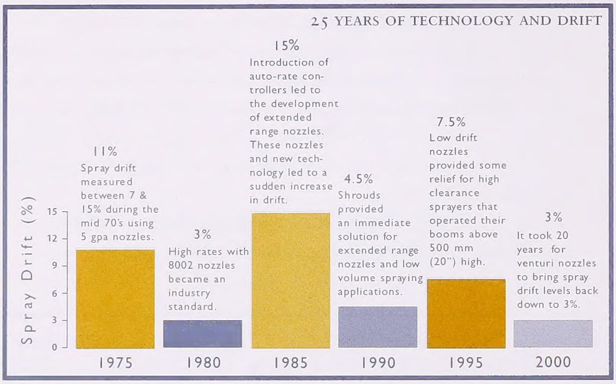
- Low drift nozzles (pre-orifice type) such as Turbo TeeJet and Drift Guard reduced spray drift by 50 percent compared to conventional extended range nozzles.
- Low pressure venturi nozzles reduced airborne spray drift by 35 to 60 percent compared to low drift nozzles. These nozzles can be operated at the standard pressure of 275 kPa (40 psi).
- High pressure venturi nozzles reduced airborne spray drift by 60 to 90 percent compared to low drift nozzles. These nozzles should be operated around 525 kPa (75 psi) for improved coverage and when using automatic rate controllers.
- Based on seven seasons with field scale studies, there were little to no effects of spraying technology on post-emergent spraying of cereal crops.
- Herbicide efficacy depended more on herbicide rate, weed growth stage, population and growing conditions rather than spraying technology and water rate.
- During extremely wet growing conditions or heavy weed populations, using recommended chemical rates, spraying at early stages and using higher nozzle pressures improved efficacy, especially for venturi-type nozzles.
- Most spraying technologies performed similar at low and high water rates when appropriate nozzles were selected and used as recommended.
- Air assist systems showed more potential in fungicide applications, while electrostatic sprayers were more effective in pre-burn applications.

THE WAR ON SPRAY DRIFT

Technology offers best solution but the war is not over yet.

From crop safety, economic, legal liability and environmental aspects, minimizing drift is a key element of truly sustainable crop protection.

The AgTech Centre has used wind tunnel simulation along with extensive field-scale research to evaluate key sprayer technologies for reducing spray drift in typical in-crop, disease control and desiccant technologies.



The history of nozzles

The story of spray drift is the history of nozzles itself. Auto-rate controllers introduced in the 1980s led to the development of extended range nozzles. These nozzles and new technologies, such as low volume sprayers, led to a sudden increase in spray drift of up to 15 percent. Since then, researchers have been targeting spray drift as an area for needed improvement.

Nozzle research with specially designed field-scale sprayer equipment that represents a range of sprayer types has generated some interesting results in the bid to reduce airborne spray drift.

Key points include:

- Low pressure venturi nozzles, such as Air Bubble Jet and Airmix, reduced drift by 35 to 60 percent compared to preorifice nozzles. For best coverage, these nozzles should be operated between 150 and 400 kPa (20 and 60 psi), averaging around 275 kPa (40 psi) but usually not lower than 200 kPa (30 psi.)
- High pressure venturi nozzles, such as TurboDrop and AI TeeJet, reduced drift by 60 to 90 percent compared to pre-orifice nozzles. They can be operated at 275 to 825 kPa (40 to 120 psi), with an average of 525 kPa (75 psi) but not lower than 275 kpa (40 psi).
- If spray drift is a concern, nozzles should be operated at the low end of the range of pressure for the nozzle. If extra coverage is needed, nozzles can be operated at the high end of the pressure range.
- High pressure venturi nozzles are best suited for high clearance sprayers if drift is the primary concern. The nozzles produce a coarser droplet size, which has a lower risk of drift when higher spray booms are used. Low pressure venturi nozzles are sufficient with pull-type equipment.
- Shrouds are still needed. The combination of a conventional sprayer equipped with low pressure venturi nozzles and a shroud produces optimum drift reduction at higher wind speeds.

The bottom line on drift

Venturi nozzles brought spray drift levels back down to the range seen in the early 1980s. While improved sprayer technology has helped reduce spray drift dramatically in recent years, the war on spray drift is not over.

Farmers want to use lower water rates for economic and practical reasons and as a result must make a compromise between coverage and drift. Until farmers don't have to chose between those, technology will continue to be developed and applied as weapons against drift. It's up to producers to use the best technology available for the specific spraying situation.

Industry drives sprayer Web resource for farmers

The AgTech Centre is one of a number of industry players involved in a new sprayer technology research and information resource called *Canada Sprayer Guide*.

Located at www.canadasprayerguide.com, *Canada Sprayer Guide* is designed to help producers, and those who serve producers, keep up to date on the latest developments in crop protection technology with a theme of technology for a sustainable industry. The goal of the Guide is to provide common sense, realistic advice on this important area of agricultural production.

Maintaining connections with industry plays an important role in the research and extension of the AgTech Centre. This industry site complements resources such as Ropin' the Web www.agric.gov.ab.ca and the Alberta Agriculture, Food and Rural Development's call centre 310-FARM.

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